MASS.
ED21.2:
A655

UMASS/AMHERST
312066 0271 3212 0

GOVERNMENT DOCUMENTS
COLLECTION
APR
University of Massachusetts
Depository Copy

APPROACHES TO ENERGY CONSERVATION:

A GUIDE FOR MASSACHUSETTS SCHOOL ADMINISTRATORS

MASSACHUSETTS DEPARTMENT OF EDUCATION, JANUARY 1980

MASSACHUSETTS BOARD OF EDUCATION

Charles T. Grigsby, *Chairperson*
Anne H. McHugh, *Vice-Chairperson*

John Anthony
Millie Clements
John W. Bond
James L. Green
Howard A. Greis
Mary Ann Hardenbergh
Armando Martinez
Joseph C. Mello
Edwin M. Rossman
Donald R. Walker

Gregory R. Anrig, *Commissioner of Education, Secretary*

Ex-Officio Member
Laura B. Clausen, *Chancellor*, Board of Higher Education

Division of School Facilities and Related Services
Fred E. Williams, *Associate Commissioner*
Prepared by the Bureau of School Management Services
Leo P. Turo, *Director*

Produced by the Bureau of Educational Information Services
Richard A. Gilman, *Director*
Cynthia F. Nadreau, *Production Coordinator*
Sharon Fisher, *Designer*

Graphic production services by Joyce E. Wu

The Massachusetts Department of Education insures equal employment/educational opportunities/affirmative action regardless of race, color, creed, national origin or sex, in compliance with Title IX, or handicap, in compliance with Section 504.

Publication of this Document Approved by Alfred C. Holland, State Purchasing Agent.
1500-4-80-152599 Estimated Cost Per Copy $.99

APPROACHES TO ENERGY CONSERVATION:

A GUIDE FOR MASSACHUSETTS SCHOOL ADMINISTRATORS

GOVERNMENT DOCUMENTS
COLLECTION

APR 26 1983

University of Massachusetts
Depository Copy

TABLE OF CONTENTS

PREFACE iv

MANAGEMENT OF ENERGY CONSERVATION PROGRAMS AND CRISES 1

ENERGY CONSERVATION IN SCHOOL FACILITIES 5

DISTRICT LEVEL PLAN FOR CONSERVATION 12

ENERGY CONSERVATION IN SCHOOL CURRICULUM 22

ENERGY CONSERVATION IN SCHOOL TRANSPORTATION SYSTEMS 26

APPENDICES 31
  A. Glossary of Energy Terminology 31
  B. Conversion Table 36

PREFACE

The impact of energy conservation on Massachusetts schools has resulted in a concerted effort to develop policies, objectives and conservation measures to reduce the consumption of energy in the everyday operations of schools. This book has been designed to provide local school administrators with a basic knowledge and understanding of the need to conserve energy, identify energy conservation management methods, provide suggested long and short range solutions, and employ ideas and methods to conserve energy.

The sections of the book have been devoted to the major areas of energy conservation in local school districts. The areas dealt with are: *Management*—Vital to planning, implementing, monitoring and evaluating energy conservation programs and managing crises; *Energy Conservation in School Facilities*—Practical energy-saving strategies for school district facilities planners operation and maintenance personnel, and other school district staff concerned with energy conservation systems in school facilities; *District Level Plan for Conservation*—This format may be used by school districts in the development of energy conservation programs, and includes a comprehensive list of energy-saving ideas; *Energy Conservation in the School Curriculum*—Describes the importance of energy conservation for educators and provides the philosophical basis for teaching energy conservation in schools; *Energy Conservation in School Transportation Systems*—A description of energy conservation techniques in school bus transportation and driver education programs, including a list of energy conservation suggestions.

Some of the energy conservation information in this book was produced by the Interstate Energy Conservation Leadership Project (IECL) in the belief that state education agencies can play a key role in the conservation of energy. The IECL, funded by the U.S. Office of Education through the Colorado Department of Education and working in cooperation with the states of Massachusetts, North Carolina, Washington and the Federal Energy Administration compiled and documented energy conservation information.

The energy problem and its financial effects upon school districts are large. As educators, students, and indeed, all citizens we must do our share in conserving energy and the dollars that energy represents by auditing energy use and taking practical steps to provide effective leadership in the conservation of energy.

Leo P. Turo

I. Management of Energy Conservation Programs and Crises

ENERGY CONSERVATION PROGRAMS MANAGEMENT

Management is vital to a successful conservation program. The commitment of management is to identify action to be taken, plan and organize, decide on objectives, outline procedures, assign responsibilities, monitor, and evaluate energy conservation programs.

ORGANIZING AND MANAGING ENERGY CONSERVATION PROGRAMS

Communicate to all plant employees management's commitment to energy conservation.

Provide an organizational plan for implementation and ongoing surveillance of an energy conservation program. Plan should include:

- Responsibilities of an energy conservation coordinator or committee.
- Development of an effective communication system between coordinator and major divisions, departments, and students.
- An energy accounting and monitoring system
- Educating and motivating staff and students.

Establish training programs as needed to provide education for staff and students on all aspects of energy conservation.

Provide continuing motivation for staff in the form of clear objectives, standard operating procedures, efficiency charts, and the like.

IMPLEMENTING ENERGY CONSERVATION PROGRAMS

- Plans outline the details of the energy survey, balance analyses, and other diagnostic steps that will determine the actual energy saving actions to be taken by whom and by what date.

Conduct an energy survey.

Tabulate types of energy consuming devices found in your energy survey.

List the energy conservation opportunities resulting from your survey.

Obtain the necessary management approval.

MONITORING ENERGY CONSERVATION PROGRAMS

- Plans outline the continuing monitoring and accounting actions that will keep up the momentum of energy conservation within the educational environment.
- Establish an energy monitoring program for:
  - Staff
  - Students
  - Plant as a whole
  - Community
- Utilize the monitoring system to pinpoint problem areas in energy consumption.
- Establish a maintenance program to provide continuing attention to facilities and equipment that waste energy.
- Establish a periodic inspection program to ensure that energy conservation standard operating procedures are being followed.

EVALUATING ENERGY CONSERVATION PROGRAMS

Inventory of all Energy Using Devices.

Energy Consuming Equipment and Systems Checklist.

Summary of Energy Saving Opportunities and Estimated Payback Periods.

Organization and Management of the Energy Conservation Program.

- Specific steps necessary to manage and implement an energy conservation program.

Energy Conservation Maintenance/Surveillance Checklist

- Provides initial guidance to the opportunities and requirements of a successful maintenance and surveillance effort.

Energy Evaluation

- Provides a summary of specific advantages and disadvantages of an energy monitoring method.

ENERGY CRISES MANAGEMENT

The sudden absence of energy needed to maintain the school district, such as heating fuel, electricity and gasoline can seriously affect the every day operation of the educational plan. Contingency planning for such crises must be developed. Awareness of what to do and what remedial steps to take should be part of an energy conservation plan. The contingency plan must be ready and understood by all so as to be put into operation smoothly and expeditiously by personnel, student, parent and community support of the schools. Reductions in energy use and conservation extend beyond educational programs and impact on the community as a whole.

If there is a complete absence of energy for heating of school facilities, lighting and school transportation, the following suggestions are for contingency planning:

- Check manuals, blueprints and contact experts before shutting down school building and complicated equipment.
- Maintain sufficient heat to keep pipes and fire protection equipment from freezing.
- Drain as many pipes as possible.
- Use antifreeze in toilets, sinks and fire protection equipment.
- Do not heat spaces where freezing temperatures can be maintained.
- Shut off exhaust fans and close outside air dampers.
- Board up and caulk exterior doorways and windows where feasible.
- Make periodic inspections and evaluations of contingency plan.
- Involve community in alternative educational plans for students unable to attend the closed school facilities.

In case of an energy shortfall, problems could confront schools due to the shortage. The following are some suggested processes and solutions to energy shortages in electricity:

- Conduct a survey of electrical consumption in order to determine where essential use is necessary and areas where consumption can be reduced without reducing the efficiency of the learning process and health factors.
- Develop an electrical conservation plan, through orientation, involvement of school faculty, maintenance staff and students. Establish priorities, reductions and alternatives.
- Evaluate the electricity consumption plan periodically in order to identify the effect on the school districts conservation planning.

If a shortfall in heating fuels should occur resulting in the reduction, the following are some suggested ways to deal with heating needs:

- Survey the consumption of heating fuels and determine where heating conservation measures can be employed.
- Survey all heating controls in the school facility and set day and night heat levels consistent with energy conservation measures.
- Schedule school operations in cadence with current heating fuel supplies.
- Involve all school personnel, students and citizens in the effort to contain the heating of school buildings within the current heating fuel supplies.
- Consider adjustments in the school calendar, if necessary.
- Develop an information program to inform staff, students and parents of heat conservation plans.
- Evaluate the heating plans periodically consistent with heating fuel supplies.
- Consider alternative plans not requiring heating fuels.

If gasoline or diesel fuels should come in short supply, the following are some suggestions to consider in the use of gas and diesel fuels:

- Identify the uses and users of school-owned equipment such as tractors and school buses.
- Determine the priority uses and users of gas and diesel fuels in the school district.
- Attempt to locate alternative suppliers.
- Check efficiency of school district-owned equipment.
- Review school transportation policies relative to ridership, walkers, and scheduling and routing.
- Meet with school bus contractors to review supplies on hand and future deliveries. Make plans to adjust school transportation program consistent with gas and diesel fuel availability.
- Consolidate and reduce educational programs requiring school transportation.
- Form a committee involving teachers, parents, school committee members, students and transportation personnel to study and seek solutions to the problem.
- Set an evaluation plan to review action taken to reduce the use of gasoline and diesel fuels.

II. Energy Conservation in School Facilities

INTRODUCTION

According to *American School and University* magazine's annual maintenance and operations cost study, the median U.S. school district spent, in 1972, about $270 for each 1000 square feet. Estimates by the National Science Foundation indicate that today's buildings waste as much as 40 percent of the energy they consume. A quick calculation shows that taxpayer's money in the amount of $108 per 1000 square feet of educational plant went up the flue or out the window in a median district.

For school administrators, energy conservation in the design, construction, programming, and operation of school plants is both an essential and an ethical obligation. Essential because of the rapidly rising costs and unpredictable supplies of energy; ethical because the school district administration is both the steward of public monies and the leader of education in the community.

Recent experience is showing that energy conservation programs in schools can result in dramatic and immediate savings in tax dollars. Data gathered recently by Educational Facilities Laboratory [EFL] indicate that *at least* $4,000 per year in fuel and utility costs in a typical elementary school can be saved by reducing energy waste. The amount comes to over $10,000 per year in secondary schools, One small Colorado school district, Northglenn, through careful auditing of its energy usage patterns and through an organized program of energy conservation, is now saving in excess of $3,000 *per month* on its gas and electric bills.

It is hoped that the following discussion of energy conservation in school facilities will encourage district personnel to follow the successful examples of other school districts in reducing energy waste.

ENERGY CONSERVATION IN EXISTING FACILITIES

When an educational facility is viewed as a system composed of plant, students and teachers, materials, support staff and program, one can identify three levels at which energy-saving strategies can be developed and implemented. These levels are:

1. *The programmatic*—the educational program and schedule of activities taking place at the school.
2. *The operational*—how the facility and its supporting systems are run to house and support these educational activities.
3. *The physical plan and its operating system.*

In general, programmatic and operational changes are only modifications in the way the existing facility is used and, therefore, usually entail little or no expenditure. On the other hand, changes to the physical plant or to one or more of its operating systems may be quite expensive.

Practical energy-saving strategies at each of the three levels are discussed in the following sections.

PROGRAMMATIC MODIFICATIONS

The educational program and schedule of daily activities are normally considered as a stable factor around which all other elements in the school system must revolve. The school's program reflects its primary function; the encouragement of learning and the sharing of knowledge. Most programs and schedules, however, have some room for trade-offs which can result in energy savings.

One such trade-off is the proper use of a plant at night or on weekends when it is less than fully occupied. If activities during these times are scheduled in such a way that all the spaces used are in a single heating or cooling zone, or are at least adjacent, the remainder of the plant can be shut down and the minimum of energy used.

The effect of programmatic changes on energy consumption is shown by a study of a "typical" Colorado school commissioned by the Colorado Department of Education. Using a computer simulation package, the study discovered the following energy variations resulting from variations in scheduling:

> Shutting down the school completely during Christmas vacation *and* the month of January could result in an annual heating fuel savings of 23.9 percent.
>
> Extending Christmas vacation another week could result in heating fuel savings of 5.8 percent per year.
>
> Starting school as late as 11:00 a.m. in the winter and running later in the afternoon would save only about five percent of the heating fuel per year.
>
> Using the school on a year-round basis, requiring air-conditioning in the summer months, would add 61.2 percent to the annual fuel and electricity bill.
>
> By turning heat on at 7:00 a.m. and off at 3:00 p.m. indicates that actual fuel consumption could be reduced by 13.8 percent annually.

Another scheduling technique that encourages energy conservation involved programming space use so as to place visual tasks in areas of specially designed lighting. This procedure can save considerable electrical energy by allowing a reduction in the general lighting level. In addition, visual tasks themselves may be modified. For example, the reading of #2 pencil on manila paper requires about fifty times as much light as reading felt-tip pens on matte white paper.

OPERATIONAL MODIFICATIONS: CUTTING WASTE IN BUILDING LIGHTING

There are three ways of reducing a school plant's waste of lighting energy. These may be used separately or in concert. They are: (1) reduce the number of lamps; (2) turn off the lamps in unoccupied spaces; and (3) make use of natural lighting when available.

1. Reducing the number of lamps: Lighting wattage in existing buildings may be reduce either by removing a percentage of flourescent tubes or by replacing incandescent lamps with bulbs of lower wattage. (Table I shows the annual costs of maintaining various lighting levels.) If this approach is used, reductions in teaching space lighting levels should be based upon careful consideration of what amount of lighting is appropriate.

Programs of this sort have been implemented in school districts all over the country. The facility director of an eastern district reported that since voluntary light use reduction efforts rapidly lose their fervor, the only way he can achieve his desired savings is by removing tubes. The director of an energy conservation program in a West Coast district reported that he had 500 watt incandescent bulbs in classrooms replaced with 350 watt bulbs over a weekend and space users never noticed the difference.

2. Voluntary light turning-off programs: The failure of Americans to turn off lights in rooms they leave is so notorious that a few years ago an American President was the butt of humor because of his attention to this detail. Few school buildings achieve more than 75 to 80 percent space utilization and if lights were conscientiously turned out in vacant spaces, up to one-quarter of the electrical bill could be saved with *no* change in lighting levels.

Numerous school districts and institutions of higher education have instituted programs to encourage the turning off of unused lights and other equipment by their facilities and students. Some of the activities by zealous savers can have comical results as anyone who has sat in a suddenly-darkened office cubicle or toilet stall can attest. Unfortunately, the success of these programs seems to fluctuate in an inverse relationship with the availability of gasoline.

Another approach, somewhat more consistent in its results, is to appoint student or staff monitors with responsibility for turning off lights when a room is empty and to periodically check the rooms in the plant for use.

3. Use natural light if you have it. If a building receives natural light through windows and skylights, the use of artificial lighting in the rooms should be adjusted accordingly. Some older school plants have separate switching circuits for banks of lights near the windows, a useful idea which could be added to all school plants with large window areas and, if properly used, could result in considerable energy savings. A study indicates that each linear foot of a properly designed window (measured along the sill) can save up to 100 kilowatt-hours per year.

CUTTING WASTE IN HEATING AND COOLING

The maintenance of a healthful and comfortable interior environment requires that the temperature and humidity be maintained within the "comfort zone" of conditions illustrated in TABLE I. Although conditions are often expressed as a single set of figures (such as 75°F, 50 percent relative humidity), an examination of TABLE I shows that comfort conditions are actually a range of values, slightly different for summer and for winter and for different activity levels.

In an existing plant, maintenance of these desired conditions can be assured (with minimum energy consumption) by taking three steps: (1) setting the thermostats lower in winter and higher in summer; (2) reducing and controlling the amount of outside air taken in; and (3) using appropriate setbacks when the plant is not occupied.

1. Change thermostat settings: The study sponsored by the Colorado Department of Education found that reducing the thermostat setting (room temperature in classrooms from 75°F to 68°F in winter could save an estimated 23.4 percent of the annual heating fuel consumption. From an examination of the comfort zone in TABLE I, the reader can see that a setting of 68°F is still within the range of comfort, provided that the humidity level is not too high. Spaces in which more rigorous activities take place can be further reduced in temperature; in fact, such reductions are beneficial to the person engaging in these activities. The following figures are given for space temperatures by the New York State Education Department's "Energy Usage Guidelines:"

Classrooms	68°F	Storage and other non-student spaces	50-55°F
Shops	63-65°F		
Gymnasiums	63-65°F		

The wearing of suitable clothing, especially covering the arms and the ankles, increases comfort over a broad range of temperatures, and the school should recommend warm apparel in winter and cool in summer.

2. Control outside air intake: Outdoor air is introduced into a building in two ways—intentionally for the purposes of ventilation and air freshening, and unintentionally through flaws in the building fabric and by the opening and closing of doors and windows. Whenever outside air is introduced into the building, it must be treated—heated or cooled—to match the conditions of the air in the spaces of the building. *Up to one-half of the total heating and cooling bill may come from this treatment of intentional and/or accidental outside air intake.*

Controlling outside air introduction so that only as much air as is required is brought into the building is one major energy savings in school plants. In buildings with mechanical ventilation, this control includes sealing of the plant against accidental introduction of outside air, or "inflation," checking the settings of outside air intake dampers to insure that only the desired amount of air is actually being introduced, and shutting off the outside air fans when the plant is not occupied. EFL research indicates that the operation of intake and exhaust fans during unoccupied hours is a major cause of energy waste.

An energy study, undertaken in Fairfax County, Virginia, estimated that in buildings relying upon intake and exhaust fans, a reduction of 50 percent in the outside air intake is possible. This reduction, which still puts ventilation rates above the minimum requirements, would result in annual energy savings of about 25 percent. In a typical secondary school, this means an annual savings of about $11,000 *with no investment*.

Control of outside air introduction in buildings relying on natural or gravity ventilation is trickier, but taking appropriate action, such as weather-stripping windows and sealing cracks, can still result in energy savings. The Fairfax computer simulations put these savings at about 35 percent if the level of outside air introduction could be held to recommended levels.

3. Setback of the system: Appropriate setback of the mechanical system during unoccupied periods is another source of energy savings which offers big results for little cost. Although most buildings built in the last three decades are equipped with setback controls, EFL experience indicates that as many as one in three of these units may not be effective because of malfunction and a larger proportion because of improper use. This is to remind the reader that even if an energy-saving device is provided, a certain amount of supervision is necessary to insure that it is used and used properly.

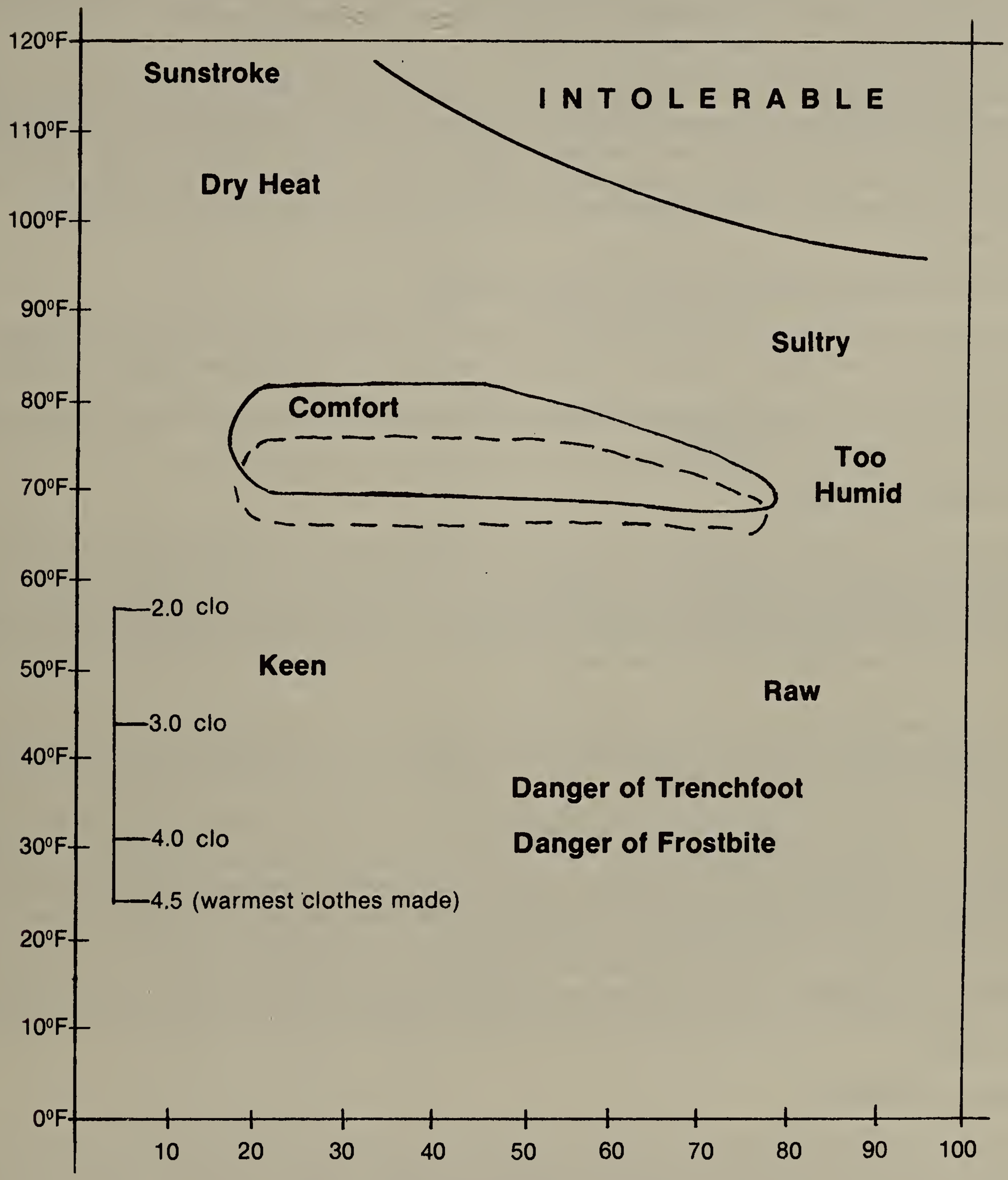
In setback, the load on the mechanical system is reduced by allowing the inside temperature of the building during unoccupied hours to fall in the winter and to rise in the summer—in mild climates, the system may be completely turned off during these times. Most thermostats allow a heating setback to 55°F, and other units are available which go lower than this figure. The Colorado and Fairfax county studies indicate that a setback of winter temperature to 60°F from 70°F (roughly the same as any 10°F setback) will result in savings of from 12 to 20 percent of annual heating fuel consumption. For the Virginia high school mentioned earlier in this discussion, this means annual fuel cost savings of over $18,000.

PROPER SYSTEM MAINTENANCE

It is a truism that well-maintained systems operate more efficiently. In spite of this fact, however, one energy expert has estimated that as many as 80 percent of school building mechanical systems operate improperly due to poor or nonexistent maintenance.

Part of this problem is due to the absence of appropriate training programs for custodial, maintenance, and supervisory personnel. Two notable efforts to alter this situation have offered to make their materials and assistance available through the IECL Clearinghouse. The Division of Engineering of the North Carolina

TABLE I



Relative Humidity (Per Cent)

FIGURE I

Human Comfort Zone

SOURCE: VICTOR OLGYAY, *Design with Climate*, pp. 19-24.

Department of Education has an extensive and successful program of workshops and video tapes which are used to train plant custodians and maintenance personnel in proper maintenance and operations of their buildings. This program includes such energy-related topics as testing burner efficiency and manual shifting of electrical load to reduce peak demand.

The second program has been developed as part of a community college curriculum by the Portland (Oregon) General Electric Corporation (PGE) in cooperation with a community college and several area school districts. In this program, the community colleges offer regular courses for custodians and maintenance personnel with full credit available. PGE provides materials and instructors for the program. Further information about both of these and other programs can be obtained from the IECL Clearinghouse.

ENERGY SAVINGS THROUGH PLANT MODIFICATIONS

Assuming that a plant is operating relatively efficiently, that is, with little or no wastage of energy, it may be necessary to invest funds in the plant in order to achieve further energy savings.

An effective analysis of energy-saving strategies, which require investment, cannot be made without some form of life-cycle cost analysis.

MECHANICAL SYSTEMS

Wearing out of the system or of its components or the preparation of a cost/benefit analysis may indicate the advantage of replacing all or part of the mechanical system in an existing plant with one which has better energy consumption characteristics. For example, providing a separate water heater or a smaller supplementary boiler may result in fuel savings in mild climates. It may also be found that existing mechanical plants have surplus capacity which may be used for additions, other plants, or other uses.

Several manufacturers now produce systems which are designed to be placed into existing plants and which provide efficient heating, ventilating and/or cooling while making extensive use of salvageable portions of the plant's existing systems.

In plants with central systems, the use of a heat recovery device between the outdoor air intake and exhaust air streams should be considered. The estimate prepared for the Fairfax County energy study indicated that at the two secondary schools to which this technique was applicable, such devices would pay for themselves in 5.9 and 6.8 years respectively. The annual energy cost savings at each of the two schools would not be in the neighborhood of $16,200 with these devices.

Improved control systems can be fitted to most existing plants at moderate expense and can greatly reduce consumption and costs. Time-sharing computer control of building systems is also available in some locales.

LIGHTING SYSTEMS

Upgrading of the lighting system of a plant is a common element of most modernization programs. When such upgrading is done, the designer should be careful to select the most efficient type of lighting source and to design it for low general levels with higher levels only where needed. The higher the lighting output per watt of input power, the lower will be the energy consumption to achieve any desired level of lighting—Table II lists some available high output lighting systems.

Switching patterns for lighting should allow for use of daylight and for some flexibility of use. The exterior banks of lights should be switched, either manually or automatically by photoelectric cells, to permit turning them off when adequate natural light is available. Two-level switching may be provided *and* teachers instructed in its use, to allow varying light levels in the classroom to respond to different educational activities.

TABLE II

EFFICIENCIES OF VARIOUS LAMP TYPES

Flourescent lamps provide three times the lumens per watt of a standard incandescent (filament) lamp.

Flourescent lamps lose efficiency at their ends. Efficiency is gained by the use of fewer and longer tubes:

2-24 inch cool white lamps = 50 lumens per watt

2-48 inch cool white lamps = 70 lumens per watt

2-96 inch (800 MA) lamps = 73 lumens per watt

High Intensity Discharge (HID) lamps:

400 watt metal halide lamp = 75 lumens per watt

1000 watt metal halide lamp = 85 lumens per watt

SOURCE:
Charles D. Gibson, "Energy Saving Efforts Related to Lighting" (paper read to Southwest Regional Conference of the Council of Educational Facility Planners, International, Sacramento, California, April 20, 1974).

In this section, a number of techniques which may be used to conserve energy in existing plants have been introduced. An effort has been made to view the school as a system composed of a number of elements—plant, users, program, schedule—and to show how energy may be saved with each of these elements.

A great deal of energy can be saved, with little or no cost, by looking at the energy that plants are actually doing and then by reducing excessive and unnecessary operations and activities. Squeezing this waste out can result in annual cost savings of at least $4,000 in a typical elementary school and in excess of $10,000 in a typical secondary plant. Modifications requiring investment can and will produce further energy and cost savings if wisely made—life-cost analysis can help direct these investments.

III. District Level Plan for Conservation

AN OUTLINE FOR A DISTRICT-LEVEL PLAN FOR ENERGY CONSERVATION

There is, of course, no single format for an energy conservation program which will adequately fill the needs of all school districts. There are too many variables involved from one region of the country to the next. In the process of reviewing a number of conservation programs there are several features that are shared by all successful conservation efforts. These include:

a) The formation of a district energy conservation committee or team which involves as many segments of the educational community as is practical.

b) The assignment of specific responsibilities to specific individuals.

c) Careful planning in the development of guidelines.

d) The recording of energy use patterns—an "energy audit"—for each building in the district.

e) Persistent follow-up and evaluation efforts to see that established guidelines are followed.

In the action that follows we have relied heavily, although not exclusively, upon the experience of Colorado's Northglenn school district which has had extensive experience organizing and conducting a conservation program. During the first nine months of 1974 this suburban district saved an average of over $3,000 per month on its gas and electricity bills in spite of a 5% increase in rates.

THE DISTRICT ENERGY CONSERVATION TEAM

The word "team" is important here. Any conservation effort, if it is to be successful, must have the cooperation from all elements of the educational community. The size and composition of the team will vary according to the needs and aims of the school district involved. A typical energy conservation team from a large school district might involve the superintendent, building principals, food services personnel, the business manager, the Parent-Teachers Association, the teachers, the school committee, the students, the maintenance and custodial staff, and the transportation staff.

It is suggested that the selection process for this committee be conducted thoroughly and carefully. Persons selected should be sincerely interested in the project and there should be a reasonable expectation that they will actively participate.

Some observations on the categories of personnel involved in the team: The Northglenn experience suggests that it is highly important that the district superintendent be "visible" in all phases of the program either through his representative or, preferably, in person. The presence of the superintendent lends the sense of direction and purpose to the conservation effort. It is also important that *one person* be selected as team leader.

In Northglenn, a district-level maintenance team was organized. This team made regular visitations to each school to asess its energy usage and its conservation needs. It is suggested that wherever possible, conservation teams be organized on the school building level as well.

SPECIFIC DUTIES FOR SPECIFIC PEOPLE

The implementation of the guidelines drawn up by the district conservation team must not be left up to chance or the good intentions of the program participants. Conservation programs are effective only when specific tasks are made the responsibility of specific individuals. Moreover, it is important that each member of the district team be aware of the person responsible for specific duties. Wherever possible there should be some system that insures that persons signify in writing that their task has been completed.

PLANNING FOR THE DEVELOPMENT OF GUIDELINES

There should be ample time set aside for the planning phase of any conservation program. Participants should be notified well in advance of the time, place, and purpose of the planning meeting. An agenda should be prepared well ahead of time. If the scope and intent of the program warrants, more than one meeting may be necessary. Organizers should not be discouraged if this planning phase seems to be eating up time. A successful conservation program is founded on careful planning and well conceived procedures.

The following are some suggested agenda items that might be explored during the planning and organization meetings of the conservation team:

- The assignment of responsibilities and tasks to specific groups and individuals
- A thorough review of the district's energy situation
- Strategies for the involvement of the entire educational community
- The planning of an energy audit for the school district
- The formulation of evaluative and follow-up procedures
- The setting of goals and the establishment of time-frames for the achievement of these goals
- The planning of a public information program to inform district personnel and the community about the existence of the project and its goals
- The preparation of energy conservation checklists for district and school building use
- The possibility of consulting outside experts in the field of energy management.

AN ENERGY AUDIT

An energy audit involves developing a record of the energy use patterns in each building in the district. (Not just schools but garages, storage areas, and administrative buildings as well.) The Energy Audit is an indispensable tool in any conservation program. It serves the following purposes:

1) It shows where energy money is going and therefore pinpoints areas where energy savings are possible by providing monthly energy cost comparisons

2) It makes possible the preparation of an "energy budget" so that administrators can begin to think of dollars and BTU's in the same terms

3) An Energy Audit, by showing graphically where energy costs are concentrated, encouraged students, teachers, and administrators to try harder to cut energy waste

A school district should attempt to collect a base amount of information on each of its plants. At the very least this should include: The type and amount of each fuel used; the amount of electricity used; and the peak demand level for this electricity.

District personnel may meet with some initial difficulty in establishing the history of a plant's energy usage. Records may not have been properly maintained or they may be difficult to locate. But as information gathering techniques become more advanced, the audit procedures will be made to yield more useful information such as energy dollar cost per student, per plant, per squre foot, etc.

It should be mentioned here that very often the utilities company serving the school district offer their help and cooperation in conducting energy audits and usage measurements. In some regions this service is provided free of cost to the district.

A number of different audit forms are included in this report for the reader's inspection.

FOLLOW-UP AND EVALUATION PROCEDURES

Even the best of programs tend to lose momentum with time. Follow-up efforts should be planned in order to overcome any inertia that may set in. This can be managed in a number of ways but it is essential *that people, not just paper*, be involved in this process. For example, a letter from the superintendent urging principals to step up their conservation efforts is not half as effective as a constructive visitation from a district maintenance team to identify energy consumption problems and correct them. These visitations, by the way, should be done in the spirit of rendering assistance and should not be undertaken so as to pose a threat to the school's principal or its maintenance and custodial staff. It is important that all district personnel involved in the project feel as though they are working together for a common goal.

The materials accumulated as a result of the energy audit will, of course, provide an excellent data base for the purposed of comparison and evaluation. It should be mentioned in this regard, however, that some disagreement exists as to whether the results of the monthly energy audits for district plants should be published. Those who argue negatively say that this procedure promotes hard feelings on the part of those administrators whose schools have not done well in energy conservation efforts. The argument in favor of making these monthly audits public say that this stimulates the desire to conserve energy and encourages a spirit of competition. The Northglenn school district, incidentally, publishes the results of their audits. The district has found that, overall, the publication of results has had a positive effect.

CHECKLISTS vs. SUGGESTIONS

In consulting this section the reader should bear in mind the distinction between a "checklist" on the one hand, and a "list of ideas" on the other.
In terms of an energy conservation program, a "checklist" sets out a list of duties for which some person is specifically responsible. In other words, a checklist is meant to be "checked off" by someone whose job it is to take care of the items in question.

The *list of ideas* included here may be altered or restructured so as to produce a checklist. If this is the intent of the organizers of a conservation program they should remember that in order to be effective a checklist should have at least some of the following characteristics:

1. The checklist, wherever possible, should bear the names or titles of those responsible for performing the duties on the list.
2. The list should include a space for a signature (note: a signature, not just a check mark) and, where applicable, a place to indicate the time and date when the item was taken care of.
3. Checklists, wherever possible, should be kept in a convenient and permanent location (i.e. for a transportation checklist, the bus garage—for a maintenance list, a place where the appropriate personnel are regularly located).
4. Checklists should be collected and reviewed on a regular basis by supervisory personnel.

A word of caution: The literature of energy conservation in school facilities is glutted with so-called checklists. One gets the distinct impression that too often school administrators fool themselves into thinking that simply by handing down checklists energy consumption will magically drop. Nothing could be further from the truth. Checklists are merely one means to an end, and in order to be effective they must be used properly. To repeat a point made earlier, successful programs are carried out by *people, not paper*. Responsibility for the handling of the checklist must be delegated and there must be some administrative mechanism to insure that this responsibility is carried out.

Note: This is a list of *suggestions*. Not all of these ideas will be practical or necessary in all situations.*

HEATING, VENTILATION, AIR CONDITIONING

Heating

Vacuum clean tubes on all boilers at regular intervals to obtain maximum operating efficiency.

In multi-boiler systems, eliminate as many boilers as possible and still maintain heat.

Keep tubes in condensors clean to maximize heat transfer.

Close and cover baffles and vents on rooftop or window air conditioners during the heating season.

Treat boiler water chemically to reduce scale.

Maintain fuel/air ratio specified by manufacturers to ensure maximum combustion and minimum soot production. The insulating effect of a one-eighth inch layer of soot can add 8% to a furnace's fuel consumption.

Maintain proper burner alignment and condition. Determine the efficiency of each unit. Clean burner nozzles daily. Drain air tanks daily.

Carry out a monthly combustion analysis to assure optimum efficiency.

Provide for adequate combustion air in the boiler room.

Keep fuel oil at the recommended temperature at burner tip to ensure proper viscosity for complete combustion and to keep heat transfer surfaces soot free.

Clean all combustion air blowers monthly or more often.

Lower the temperature setting for hot water that is heated electrically to the lowest acceptable level determined by building codes.

---

*IECL wishes to extend its thanks to the Ventura Public Schools, Ventura, California, and to the University of the State of New York whose conservation checklists and energy usage guidelines were consulted in drawing up this list of suggestions.

Ventilation

Do not allow the ventilating system to take in any outside air during the first half-hour of heating startup. Schools that have been empty for 12 hours or more are ventilated sufficiently by ordinary leakage.

Reduce outside ventilation to the fewest changes per hour that state and local codes permit. Consider no more than one air change per hour.

Check outside air dampers and controls regularly to be sure they are functioning properly.

Do not take in fresh air during unoccupied hours.

Regulate dampers on unit ventilators on buildings to reduce the amount of outside air brought in.

Be sure exhaust fans operate no more frequently than required. Put them on timers. Reduce speed.

Change or clean air filters on a regular basis.

Operate ventilation fans in kitchens and home economic classrooms only when cooking equipment is being used.

Do not operate air-handling units in rooms where the windows or doors are open.

Air Conditioning

Service air conditioners on a regular basis. Make sure maintenance personnel check and repair cooling towers; replenish refrigerant; examine fans, pumps, compressors, and other rotating equipment for poor seals, belt slippage, and other defects; check calibration of controls; and change filters.

Do not cool below a prescribed temperature, and do not operate air conditioning equipment when school is unoccupied.

Examine equipment to determine if several air conditioning systems can be combined to eliminate need to run and maintain several systems.

LIGHT(S)

Open window shades and draperies so as to take advantage of natural light on sunny days.

Install switches in rooms so that lights near windows can be turned off when there is sufficient natural light in that area.

Install a number of separate lighting circuits or dimmers for areas where high levels of lighting are needed only periodically.

Paint rooms and dividers with colors that reflect light. Keep walls, ceilings, and dividers clean; dark colors and dirt can reduce illumination by as much as 40 percent.

Place a brightly-colored sign next to light switches reminding people to turn off the lights in unoccupied areas.

Reset automatic timers for lights regularly to utilize all available daylight.

Check the sensitivity of automatic light controls to insure they are not triggered by fog or clouds passing over the sun.

Put lights on timers, photo cell, or astronomical clocks that turn lights off at given hours.

Outside security lights should be only bright enough to illuminate the areas needed.

When custodians are cleaning buildings at night, insist that they have lights on only in the rooms they are cleaning. When a cleaning task in a room has been completed, the lights should be turned off. Schedule daylight cleaning when possible.

Eliminate ornamental lighting.

Reduce lighting in hallways, corridors, storage areas, and outside the school to the lowest level safety and security will allow.

Initiate light turn-off programs to see that lights do not burn in unoccupied areas.

Reduce lighting levels in cafeterias, gymnasiums, and auditoriums.

Clean fluorescent tubes regularly. A tube will collect enough dust and dirt to reduce efficiency by 10 to 20 percent in 6 months and 40 percent in 2 years.

Replace lamps on a regular basis. Fluorescent tubes should be changed after 80 percent of their lamp life is used. Fluorescent lamps use more energy and produce less light during their last 20 percent of life.

Use fluorescent lights in suitable areas—they give more lumens per watt. One 40-watt fluorescent tube provides more light than three 60-watt incandescent bulbs.

Replace all outdoor and gymnasium lights with mercury vapor lamps. Use diffusers, new lens, polarizers, and special beam distributor units that can provide proper spread, focus, and use of illumination within a given space.

Inspect all light bulbs to insure that they are of the minimum voltage required.

Review recommended lighting standards. Often the so-called "minimum" standards require more light than is needed for reading and ignore non-reading activities entirely. (Lighting levels for most educational functions have doubled since 1960 and tripled since 1950.)

CONTROLS

Make sure custodians understand how to operate temperature settings on unit ventilators so they do not confuse the low-limit settings on these units with actual thermostat settings and overheat the room.

Establish the proper balance between temperature and humidity controls.

Have heating and air conditioning systems balanced regularly so that hot and cold spots in buildings are reduced to a minimum.

Shut off or put on night setback all air-handling equipment one-half hour before school closes. The building will maintain temperatures for a long period of time after controls have been shut off or reduced.

Set thermostats at the lowest setting that will not interfere with the learning process. Reduce heat in gymnasiums, locker rooms, and auditoriums. Eliminate heating in unused rooms such as closets, stairwells, etc.

Set back thermostats during weekends and vacations. Provide for overnight setback of thermostats either manually or by means of automatic control.

OPERATIONAL

Bring staff up to level of skill demanded by the equipment and controls. Establish an inservice training program for custodial and maintenance staffs. Utilize manufacturing representatives who can give instructions in operating pieces of equipment at maximum efficiency.

Recognize that operations and maintenance are two separate functions. Do not expect untrained, unskilled personnel to repair and maintain sophisticated equipment.

Curtail use of resistance-type electric equipment, such as space heaters, coffee pots, and hot plates.

Carefully develop specifications for the purchase of new equipment to insure that it is designed to use the minimum amount of energy.

Consolidate summer school classes in adjacent rooms where possible to reduce the number of air-handling units needed. Place classes around the perimeter of the building to take advantage of natural ventilation and natural light through windows.

Schedule all evening meetings, PTA, and others for a single building so that night setback temperature can be retained in other buildings.

Encourage the wearing of warmer apparel during cold weather.

Be sure all windows fit tightly. Seal all openings around windows, doors, and other places where warm air could escape. Caulk old frames. Patch broken windows and damaged doors immediately. Double glaze windows, especially those on the north side.

Survey location of each room thermostat in relation to doors, windows, and hot or cold sources. Relocate for maximum energy savings.

Avoid blocking, heating, or cooling vents with furniture or draperies. Do not put anything on top of radiators. Keep all heating sources clear of furniture, draperies, bookcases, and files.

Allow sunlight into the building on cold days and keep it out on warm, humid days. Close drapes and blinds after school to reduce heat loss through window areas in the winter and to keep solar heat out during the summer.

Limit the number of entrances students and teachers use for arrival and departure.

Make sure that energy conservation as a subject area has a place in the school curriculum.

Schedule adult education programs to meet in rooms which receive full use during the day to utilize the existing room heat.

Encourage more efficient use of AV equipment through large group viewing.

Use centralized meeting places and combine meetings to allow personnel to travel together. Hold board meetings and PTA meetings during daylight hours where possible.

Organize work crews better to reduce travel.

Reduce the number of meetings of personnel.

SUGGESTIONS REQUIRING MODIFICATION

Install automatic door-closing devices.

Install heat recovery systems to trap and reuse waste heat that otherwise might be exhausted into the atmosphere. Use reclaimed heat for hot water and reheat to eliminate need to operate additional equipment.

Install independent gas or electric water heaters to allow complete shutdown of boilers in summer. Shutting off boilers eliminates heat created by steam mains in the building and takes a big load off air conditioners. If shutting off boilers is not practical, shut off all steam mains not required for water heating.

Replace hand valves on heating and air conditioning equipment with thermostatically-controlled automatic valves.

Install storm windows. Insulate attic and outside walls.

Lower ceilings, where possible, to reduce air space for heating.

Check and repair insulation throughout the building, especially in attic spaces and on pipes, boilers, and tanks.

Install systems that use waste heat from a school building's mechanical system to heat incoming air.

Redesign, remodel, or replace obsolete or inefficient equipment.

Install systems that control the heat generated by lighting systems. Do this by capturing the heat before it enters space either by drawing return air across the fixture and back to the mechanical plant or using water-cooled fixtures.

SPECIAL CLASSROOMS

Homemaking

Cook by time and temperature for best results. Use minute timer for precise cooking operations.

Repair all equipment immediately and establish routine maintenance schedules. Have all ovens calibrated.

Use cold-water washing when possible.

Reduce the size of freezers to minimize on-site storage of frozen foods.

Limit pre-heating of ovens to the very minimum. In some cases, pre-heating is not necessary.

Decrease the amount of hot food prepared.

Don't open oven doors more than necessary to check on foods being prepared.

Keep pots and pans covered while cooking whenever possible.

Make sure burners are completely off when not in use.

Use a stopper in sink when washing dishes by hand to avoid running hot water continuously.

See to it that students in homemaking classes are made aware of the necessity for energy conservation.

Don't allow leaky hot water faucets. Locate and repair any water or steam leaks immediately.

Lower temperatures in water heaters on weekends; turn off during vacations.

Match pan size to burner unit size.

Refrigerator and freezer should be kept more than half full. Items absorb and help hold cold.

Use high heat only to bring water to a boil or to start cooking food with water. Then reduce heat level to lowest possible point.

Use small amounts of water whenever possible; they heat faster.

Keep refrigerator and freezer coils clean; replace door seal when it no longer seals tightly.

Consolidate backing activities into one day of continuous use.

Use hood fans only when necessary.

Eliminate the use of electric can openers and other "convenience" appliances.

Shops

Reduce lighting to levels actually needed in work or training areas.

Use more hand tools; teach more hand skills; assign more students per power work station.

Coordinate shop use and classroom use for more efficient utilization of space in shop area.

Restrict use of doors in shops.

Reduce the number of forges, kilns, and smelters.

Include energy conservation techniques as a regular part of the shop curriculum.

Initiate useful projects in shops to help other departments in the school with equipment, repairs, etc.

Drama

Design activities for a more efficient use of multi-purpose rooms.

Reduce stage lighting through the use of dimmers. Use less and lower light during rehearsals.

Make sure that lamps and reflectors are kept clean.

Use regular classroom more when small groups are practicing or performing.

Art

Reduce hours of kiln use.

Organize more hand operations, especially in crafts.

Business Education

Restrict the use of electric typewriters and other electric machines. Use more hand-operated equipment.

Utilize more community and business facilities for training.

Make sure that all power equipment is turned off when not in use.

Use both sides of all paper products.

Physical Education and Sports

Restrict the use of showers to the very minimum. Reduce the capacity of shower heads to cut down on the amount of hot water used. Reduce water temperature in showers.

Lower swimming pool temperature. Minimize filter pumping hours on pools.

Use solar heat for pools. Do not heat pools during warm or hot seasons of the year.

Keep gym temperature at 65 degrees or below.

Utilize commercial laundering of towels or have students bring their own towels.

Expand inter-mural competition to substitute for intra-mural.

Limit the geographical area of athletic competitions to reduce traveling by bus or car.

Conduct basketball, volley ball, and other game practice sessions outside as much as possible and during daylight hours.

Combine girls and boys sports as much as possible to reduce the number of hours facilities are used.

Shut off air-handling units and lights in gyms when physical education classes are being held outside.

Do not use electric scoreboards.

MAINTENANCE AND GROUNDS

Establish inservice training programs for custodial and maintenance staffs featuring experts in the field of thermostatic control and lighting as well as manufacturing representatives who can give instruction in operating pieces of equipment at maximum efficiency. Bring operations people up to the level of skill demanded by the equipment and controls.

Organize groundsmen and maintenance personnel assignments to minimize use of trucks. Equip maintenance trucks with all necessary tools.

Monitor use of all vehicles used in maintenance and operations.

Ration gas for all equipment. Make it stretch.

Cut grass and edge less often.

Keep all gas burning engines tuned to peak performance.

Adjust temperature in buildings where custodians work to the lowest possible comfortable temperature for physical labor.

Make warehouse deliveries and messenger service to schools on a very minimal basis.

Reschedule room cleaning to daytime as much as possible to save electricity used at night.

Do as much cleaning as possible with cold water.

Lock gas tanks on all vehicles to avoid theft.

Control purchasing of equipment to obtain the correct size.

Encourage employees to bring their lunches rather than driving home or to a restaurant.

Use the minimum amount of water for sprinkling and irrigation.

TRANSPORTATION OF STAFF

Develop innovations and creative programs to encourage staff to walk to school or ride bikes.

Provide assistance in developing car pools for teachers and clerical workers in schools.

Use central place as point of embarkation for trips involving number of people.

Coordinate conferences out of district for sharing rides.

Use closed circuit television for meetings.

Utilize conference telephones as substitutes for small meetings.

Reassign teachers and clerical workers closer to their homes.

Coordinate transportation with other county agencies.

District personnel who serve a number of schools should plan on coordinating trips to include maximum contacts and include other district personnel serving the same schools.

Educate all workers before they embark on a trip to ask themselves: "Can I deliver or do something for someone when I go on a trip?"

Let school staff members ride school buses whenever feasible.

Pick an area for staff meetings which requires the least amount of driving for all concerned. Insist on car pools.

OTHER SUGGESTIONS

Develop specifications for the purchase of new equipment to insure that it is designed to use the minimum amount of energy within the requirements of performance, longevity, and maintenance.

Explore the concept of installing a total on-site generation of electrical energy to improve on the efficiency level of remote generating stations.

Explore the possibility of using solar and other "alternate" sources of energy in new and existing facilities.

Design and print attractive, eye-catching signs about energy conservation and put them in appropriate places.

Work with city and county planners to speed up bicycle lanes. Provide adequate and safe parking areas for bicycles at schools and offices.

Encourage employees and students to bring their lunches rather than driving home or to a restaurant.

Eliminate as many meetings and conferences as possible.

Schedule major electrical power-consuming operations such as pumping water into storage tanks during off-peak hours.

Provide facilities that are the proper size that the group needs. Do not assign rooms or buildings that are too large.

Eliminate or reduce nighttime activities that require lighting.

IV. Energy Conservation in School Curriculum

Energy related themes are appropriate and urgently needed in the educational curriculum, and the following are suggestions for the integration of the energy theme in the present curricula.

It is natural that the first impact of energy or any other new theme is on citizen awareness. Drugs, or racial tensions, hit the front pages and students want to talk about them. The long lines of irritated motorists waiting for gas brought the energy crisis into the classroom. Students wanted to know what was happening and teachers wanted to tell them and to vent their own frustrations or air their own solutions.

Awareness is a proper educational goal. Students should know what is happening in their world and education should select and illuminate current problems. But awareness is related to media attention. When the gas lines disappear, when the newspapers and television look away, so do students and teachers. Once the alarm has been rung, the dire warnings given and the disasters predicted, it is hard to gain attention in the same way again. The deeper problems may remain, but students demand more than simply to be told about these problems; they want to find out how to *do something* about them.

With awareness often comes mission orientation. Drug education for instance is mission-oriented toward reducing or eliminating drug usage. The obvious mission in the energy area is the one we are now involved in: energy conservation.

It is obvious that a necessary component of almost any overall strategy aimed at reducing the tension among the three "E's" is the reduction in consumption. It is also obvious and natural for those who pilot these strategies to want to get their message loudly and clearly into the classroom. Students are valuable allies. Not only are their own life styles and habits of consumption open to influence but their parents and others in the adult population can often be reached through them.

It is exactly because of this that mission-oriented education is potentially dangerous and should be entered upon only with great caution and under careful surveillance. The schools are so potentially effective as a propaganda arm that they must be protected. Our system is deliberately designed to provide that protection.

Energy conservation is so obviously beneficial that it appears safe to relax our vigilance against propaganda and allow the various messages to come through. "Turn down the thermostats; turn off the lights; bus more and drive less." No harm can come from these prescriptions. But mission-oriented education, however worthy its goals, remains alien to the most important purposes of American education. Educators do not want to teach the students *what* to do in the situations which do and will confront them. Rather they want to teach them sound strategies of analysis and decision-making so that they can themselves, decide what to do.

The spectrum of issues to be faced in the next two or three decades is too broad for anyone to anticipate the proper targets. It is only by becoming components of the basic thrust of all teaching that energy, economics and environment will make their strongest and most lasting contribution to curricula.

There are two different ways in which a group of ideas, facts, and concepts, such as those included in the three "E's," can impact the curriculum. They can appear as new courses or curricula following the examples from the 1960's when PSSC, BSCS, Them Studies, the High School Geography Project, etc. were designed and implemented. There is a place for a course on the three "E's" in many schools and the design of three such courses would provide worthy funding projects and exciting challenges.

The curriculum is too crowded, however, and there are too many other worthy subject areas (career education, black studies, drug education, sex education, etc.) for a new course to make much impact. There will be schools which can afford a variety of courses and students with enough time, talent, and interest for a course on Energy, Economics, and the Environment (or some such title) but the bulk of the student body will not be reached in this way.

To achieve maximum impact, the themes embodied in the three "E's" must pervade the existing system. These themes must find natural employment in the satisfaction of basic learning goals. In achieving this integration into the existing curricula, they will be greatly assisted by the fact that the themes themselves are basic.

Examples of integrated curricula components are:

- There is a period in most 2nd or 3rd grade classes when the focus is on the structure of the local community. This activity provides an excellent opportunity for children to examine the community's transportation system. Students cannot only describe where people go and how they get there; they can also estimate the energy/cost of existing and alternative methods of getting people to their destination.

- The three "E's" can also be integrated into teaching units designed to explore the structure of their community and its relationship with the world outside. Students can investigate the forms and local sources of energy in their local areas and then go beyond the local community to consider ultimate sources of energy; the methods and effects of its production, extraction, and transportation. A further understanding of the three "E's" can be developed by looking at jobs that are directly or indirectly related to energy.

- Further along in the K–12 sequence, one may take advantage of geography lessons. If the world as a whole is the target, then, as they contrast regions and cultures they should also contrast energy resources and energy consumption. Energy trade becomes yet another of the global linkages which deserve emphasis.

- In another class there will be a unit on the Middle East. Here a teacher should consider the treatment of the subject incomplete if it does not involve discussion of energy resources, energy dependency, etc. How much oil is there, where is it sold, what effect is it having on the local population, how does it influence their national and international politics, etc.?

- This focus on the Middle Eastern oil picture in a geography class could be paralleled with complementary themes in other classes for those same students. In a physical science class they could study the molecules of oil and natural gas as well as the chemistry involved in cracking and refining crude oil to gasoline or in using petrochemicals to make plastics. In an earth science class, a unit on oil exploration would allow much learning to take place and there, or in a biology class, the formation of oil from once-living material would be worthy of study. In a social studies class the international politics of oil, in particular the Arab-Israeli impasse, would grow from the same theme. In an English class a group of ads from oil companies and conservation groups could be used for practical work in critical thinking. Finally, one could focus all of the students' attention, for a week or so, on related issues from some part of the three "E's" picture and by doing so make those important points, not only about the complex nature of real problems, but also about the utility of the separate academic disciplines in dealing with such problems. Admittedly this kind of educational experience is rare.

V. Energy Conservation in School Transportation Systems

INTRODUCTION

Energy conservation in pupil transportation is a major area of concern to the educational population. School buses travel more than 2.3 billion miles annually using three-hundred-sixty-million gallons of fuel. These vehicles transport 60% of the total children attending kindergarten through grade twelve.

Since the energy crunch occurred, pupil transportation has employed major conservation measures that have reduced the amount of fuel required to transport children to and from school and school-authorized activities.

Here are some of the basic guidelines for sound fuel reductions in school transportation. From these guidelines, a comprehensive checklist can be developed for use by individual school districts.

SCHOOL TRANSPORTATION

Driver Education Cars & Teachers
Maintenance Vehicles
School Buses

General Energy Practices

1. Have one person in charge of all energy for transportation.

   Designate one person to be the energy coordinator for the school district. This person will:

   - be in touch with local, state, and federal energy offices.
   - keep all forms such as FEA forms on hand and know where, how, and when to file them, and to follow up on them.
   - keep the various departments informed of the energy situation at all times, i.e., cut back in heating fuels, bus fuels, etc., or rationing.

2. Conduct an energy audit—begin at all places where fuel is used.
   a. The audit should be a month-by-month use for three years with estimates for the current year. Included should be prices, suppliers, bulk storage data, delivery dates and practices.
   b. Information should be accurate and specific, not general.
   c. Analyze fuel supply availability and current needs. Which months require the most gasoline or diesel? Which months require the least gasoline?

d. Set up action plans.

e. Set up contingencies for time when fuel is in short supply.

f. Monitor programs as devised to see if they are being effectively carried out.

Remember the school which systematically identifies and evaluates its needs and supplies, highs and lows, can tailor programs more effectively in advance—rather than be caught short.

The community should be kept informed by the media on the need and method of conservation and expect the schools to exert a leadership role.

There shall not be major operational differences between school districts within the city or local areas. Communicate with surrounding school leaders and share program ideas.

The problem of community support of the schools in place of program reductions extends beyond the basic program of education impact to the total program offered through school facilities including community services, adult education and recreation programs.

DRIVER EDUCATION PROGRAM

1. Automobile manufacturers should be encouraged to adjust their free loan program to permit greater use of intermediate and smaller size cars. Schools should be encouraged to use intermediate and smaller cars when available.
2. Public schools should conduct each behind-the-wheel lesson at the full capacity (4 students and the instructor) of the vehicle.
3. Driving simulation and multiple car off-street driving ranges should be utilized whenever feasible to reduce on-street behind-the-wheel driving time.
4. Cars should be stored centrally, not taken home by instructors.
5. Driver education vehicles shall be used only for instruction.
6. Each behind-the-wheel lesson should be accomplished in fewer miles and in a limited geographic area.
7. Freeway and open highway driving should be reduced and done at reduced speeds.
8. Use winter months primarily for classroom work and put behind-the-wheel classes on during warmer and lighter days, if possible.
9. Vehicles should be equipped with steel-belted radial tires with more air pressure in tires to reduce gasoline consumption.
10. Pre-test students and give credit for previous training and experience. Reduce hours based on results of pre-test.

SCHOOL VEHICLES—MAINTENANCE EQUIPMENT

(Other Than School Buses)

Car Pools

1. Make one office staff person available to help formulate car pools for office staff, janitors, cooks, and teachers.
2. Issue school parking places with priority granted to car pool riders for staff personnel and students.

Maintenance Vehicles

The good rules of maintenance apply to any and all vehicles, motors, and equipment.

1. Tune and maintain engines on all vehicles to peak performance. Correct faulty spark plugs, points, and carburation.
2. Avoid full throttle operation.
3. Monitor use of all vehicles.
4. Keep gas tanks full to avoid excessive evaporation.
5. Drive slowly and easily the first few miles until the vehicle warms up.

6. Ensure that vehicle tires are properly inflated or to the maximum safety level. Soft tires increase gas consumption.
7. Reduce speed limit of vehicles as low as possible.
8. Evaluate the possibility of satellite vehicle parking stations at the extremities of districts to avoid "deadheading" back to centralized garages.
9. Train drivers to use pre-planned starts and stops.
10. Install trip recorders to record driver and vehicle operation. Use this information to reduce use of gas and oil.
11. Use modern analyzing equipment to ensure fuel and oil economy for all vehicles.
12. Lock gas tanks to avoid theft.

OPERATION OF SCHOOL VEHICLES FOR STAFF TRAVEL

1. Develop an information exchange of ideas on fuel conservation between districts and with industry. Coordinate transportation with other public agencies.
2. Coordinate and consolidate pick-ups, deliveries, and messenger service between schools through the central office.
3. Make warehouse deliveries to schools on a very minimal basis.
4. Encourage all employees to ask themselves the following questions before undertaking a trip: Can someone else do it who is going that way?
5. Adopt policy for all trips by employees to meetings, conferences, conventions, etc. Limit amount of mileage allowance. Establish policy on distance to walk to meetings.
6. Utilize conference telephones as substitutes for small meetings.
7. Use telephone calls instead of home calls where feasible.
8. Install two-way radios to direct operation or redirect district vehicles to reduce mileage.
9. Request that all district employees form car pools when traveling on official business.
10. Coordinate conferences out of district for sharing rides. Use a central location as place of embarkation.
11. Have district personnel, who service a number of schools, coordinate trips to include as many stops as possible and include other district personnel serving the same schools.
12. Explore the idea of setting up a dispatcher system so that maintenance crews would not be making duplicate trips to various schools.
13. Develop a system for ordering supplies for all departments so as to keep deliveries at a minimum with a maximum load per trip.
14. Communicate with all related organizations, to share ideas...and car pools.

THE PUPIL TRANSPORTATION SYSTEM

Mechanical and Shop Program

1. Tune and maintain engines, plugs, points, and timing. Maintain and clean pollution controls.
2. Keep gas tanks full to avoid excessive evaporation.
3. Ensure that bus tires are properly inflated. Soft tires increase gas consumption. Inflate to maximum safe level.
4. Replace as soon as possible buses that use excessive amounts of gasoline.
5. Keep gasoline tanks locked with one person in charge of fueling of buses and other school vehicles.
6. Keep accurate bus records for maintenance and fuel consumption, oil changes, lubrication, etc.
7. Be sure that all changes are done at the proper mileage level.

8. Inventory all parts and supplies and order for a full school year on a planned need basis, with best price.
9. In winter climatic areas, keep all buses under cover rather than allowing drivers to take home and park.
10. Use satellite bus parking stations at the extremities of districts to avoid "deadheading" back to a centrlized bus garage.

The Drivers' Role in Energy Conservation

1. Retain experienced drivers as long as possible.
2. Re-educate bus drivers toward better fuel economy.
3. Reduce warm-up time on buses to two minutes initially and three minutes prior to starting routes. Drivers should dress warmer rather than running engines at full idle to heat buses.
4. Drive slowly and carefully the first few miles until vehicle warms up.
5. Avoid full throttle operation.
6. Avoid the "red line" even in shifting gears.
7. Drive slowly back to the bus yard.
8. Reduce speed limit to as low as practical.
9. Avoid courtesy stops.
10. Train new drivers on existing runs while bus is "deadheading."
11. Use simulators to reduce behind-the-wheel training in vehicles.
12. Increase frequency of driver in-service programs.
13. Do not warm up bus early to let heaters work. Allow heater to warm during trip from garage to first stop. (Drivers should dress warmly during winter months.)
14. Train drivers to use pre-planned starts and stops for less gas consumption.
15. Hold joint workshops with maintenance and driver personnel to improve operation.
16. Use an incentive system for reducing vehicle fuel consumption.
17. If bus drivers have split shifts, determine if their last route ends near their homes. If they do, consider having them take the bus home during the mid-day period. This will eliminate the extra driving that results from a driver bringing the bus back to the terminal, driving his car home, and then driving his car back to the terminal, etc.

School Policies Regarding Daily to-and-from School Operation

The School Bus Operation: Routing

1. Fill buses to legal capacity.
2. Re-evaluate your routing to make it as efficient as possible.
    a. Consider letting one bus bring children of all ages in from remote and longer runs using a central drop-off spot for their regular bus in town to pick them up for deposit at correct school.

    b. Stagger school hours to the extent that you are able to utilize buses to maximum load levels—not necessarily to grade levels.

    c. Utilize computerized routing facilities, if available. Eliminate overlapping of routes if you have any, whether it is between districts, schools, or several contractors.

    d. Use "zone loading" with designated stops spaced as far apart as is feasible. The bus makes fewer stops to load more pupils at the most centrally located areas. (Keeping on the time schedule becomes critical to the success of this method.)

    e. Have rural students walk up to the main road for loading. (Ride bike, parents bring them, etc.)

Other Suggestions for School Bus Operations:

1. Have older students walk to central pick-up points.
2. Lengthen distances between pick-up points.
3. Avoid courtesy stops.
4. Plan stops on level instead of on inclines.
5. Consolidate loads.
6. Plan routes to make only right-hand turns to save on idling time where safety in routing permits.
7. Use intercoms on buses to reduce stops for controlling discipline.
8. Reduce weight by removing luggage racks, extra tire, chains, etc. (during warm weather).
9. Install 2-way radios to direct operation or redirection of buses to avoid unnecessary use.
10. Monitor use of vehicles. Install trip recorders to record driver and vehicle operation. Use this information to reduce use of gas and oil.
11. Use modern analyzing equipment to ensure fuel and oil economy.
12. Use the smallest practical vehicle for long-distance, light-load runs.
13. Schedule bus routes to avoid driving up hills; stay on main roads only.
14. Let school staff members ride school buses whenever feasible.
15. Use bus contractors if available. (Escalation clauses.)
16. Hold joint workshops with maintenance and bus driver personnel to improve operation of vehicles.
17. Emission controls; i.e. catalytic converters, additives.

School Bus Operation: School Policy

1. Coordinate school calendars and start and dismissal times between elementary and secondary schools of each school system.
2. Eliminate staggered dismissal times in the same buildings.
3. Increase requirements for distances children must walk to school and to bus stops (possibly controversial).
4. Overlap elementary and secondary grades and routes. Minimize staggered school schedules.
5. Eliminate trips designed for the convenience of students between school buildings.
6. Encourage pupils to ride school buses in lieu of their own motor vehicles.
7. Eliminate buses for detention students.
8. Limit student parking and encourage high school pupils to ride school buses or form car pools.
9. Explore the satellite concept where classrooms are located away from a central campus. Rent unused houses, churches, and other buildings.
10. Develop innovations and creative programs to encourage students and staff to walk to school or ride bikes. Furnish adequate bike racks. Provide adequate safety for bikes from theft and vandalism.
11. Combine deliveries with bus routes. Use buses for deliveries where and when feasible.

School Bus Operation: Activity & Field Trips

1. Surveys show field trips use 7% to 10% of fuel allocation totally consumed for transporting pupils to and from school during a school year.
2. Reduce or eliminate all but the most necessary athletic contests.

School Bus Operation: Activity & Field Trips

1. Surveys show field trips use 7% to 10% of fuel allocation totally consumed for transporting pupils to and from school during a school year.
2. Reduce or eliminate all but the most necessary athletic contests.
3. Reduce or eliminate all but the most necessary field trips.
4. Combine field and athletic trips for more than one school.
5. Have districts share buses when holding athletic events.
6. Establish minimum and maximum distances for field trips and athletic trips.
7. Limit field trips to full bus loads only. (Perhaps picking up from several schools en route to game.)
8. Combine athletic schedules so several games can be played at the same time.
9. Encourage parents to pool with other parents in transporting children to school for late activities and for extra curricular events. Provide professional help if additional insurance coverage is needed by parents. Arrange for low cost premiums. Consider having the district assume some of the insurance costs.
10. Contract with parents to provide transportation.
11. Use charter and public transportation and their loading and unloading stops where feasible to drop off rather than return to school or homes.
12. Connect schools with cable TV or closed circuit TV for instruction, inservice meetings, and reports.
13. Use shuttle buses for students to and from athletic contests.
14. Review and evaluate all security measures in the district. Make changes to take care of any increased problems resulting from the energy crisis.
15. Change legislation which caused some buses to have capacity reduced.

Miscellaneous Supplies
(Lubricants, Additives, Accessories, etc.)

1. The smaller supply of antifreeze has placed it in critical demand because of the energy crisis. As with fuel, antifreeze availability and increased costs have put it in a high priority profile with fuel and therefore must be reckoned with when we discuss the areas of energy conservation.
2. Tips for antifreeze:
   a. Check your radiators for leaks, rust, clogging, etc.

   b. Use only the needed amount of antifreeze as mean temperature dictates.

   c. Covered or heated bus garages eliminates frozen radiators and cracked blocks.

Tires: radials appear to increase mileage

Reasons for warehousing where practical:

- Bulk purchasing
- Inventory and audit of supplies(how frequently)
- Purchase orders and requisition system
- Regulated personnel handling of supplies

Gasoline vs. diesel engines: recommended annual review for districts

Locked gas pumps (metered fuel record)

Regular bus maintenance records (should be kept and updated, as needed)

VI. Appendices

APPENDIX A

GLOSSARY OF ENERGY TERMINOLOGY

TERMS COMMONLY USED IN ENERGY CONSERVATION

BARREL (BBL)—A liquid measure of oil, usually crude oil, equal to 42 gallons or about 306 pounds.

BRITISH THERMAL UNIT (BTU)—A unit of heat energy equal to the quantity of heat necessary to raise the temperature of one pound of water 1^{0} Fahrenheit. It is equal to one-quarter of a calorie.

BROWNOUT—The deliberate lowering of voltage (and, thus, the power supplied to all users) by electric utility companies, employed when demand for power exceeds generating capacity.

CALORIE—A unit of heat energy equal to the amount of heat that will raise the temperature of one kilogram of water 1^{0} centigrade. It is approximately equal to 4 BTUs. (In scientific terminology this is the kilocalorie, 1000 small calories.)

CENTIGRADE—A temperature scale in which the temperature of melting ice is set at 0^{0}, the temperature of boiling water at 100^{0}. One degree centigrade is 9/5 of a degree Fahrenheit. The centigrade scale is sometimes known as the Celsius scale.

CLEAN FUEL—Usually means fuel in which there is very little sulfur.

COAL—A solid, combustible, organic material formed by the decomposition of plant material without free access to air. It is about 75 percent carbon.

COAL GAS—The volatile, combustible gas driven from coal in coke-making. It has a low energy density, about one-third that of natural gas (also called "fuel gas").

COAL GASIFICATION—The conversion of coal into liquid hydrocarbons and related compounds by hydrogenation, the addition of hydrogen.

COMBUSTION—Burning. Any very rapid chemical reaction in which heat and light (and sometimes a flame) are produced. Most (but not all) familiar combustions are oxidations—unions with oxygen.

COMFORT ENERGY—Any form of energy whose end use is the heating and cooling of buildings and homes.

CORD OF WOOD—A stack of wood 4 feet by 8 feet. Burned, it produces approximately 5 million calories of energy.

CRACKING—Processing that breaks down and rearranges the molecular structure of long hydrocarbon chains in ways that produce lighter hydrocarbons from heavier ones. It's used in the production of volatile fuels, such as gasoline, from crude oil.

CRUDE OIL—A mixture of hydrocarbons in liquid form found in natural underground petroleum reservoirs. It is the raw material from which most refined petroleum products are made.

DAMPER—A device used to vary the volume of air passing through an air outlet, inlet or duct.

DECLINING BLOCK RATES—A rate structure in which the charge for energy decreases as the amount consumed increases.

DEGREE DAY—The difference betwen 65°F and the average daily temperature, e.g. if the average daily temperature is 25°F, the degree days would be 40 (65-25=40). The greater the number of heating or cooling degree days, the higher the energy consumption.

DISTILLATE OILS—Any fuel oil, gas oil, topped crude oil or other petroleum oil derived by refining or processing crude oil or unfinished oils, which has a boiling range at atmospheric pressure from 550° to 1,200°F. Distillate oils account for 25-30 percent of refined petroleum products.

EFFICIENCY—The efficiency of any energy conversion is the ratio of the useful work or energy output to the work or energy input.

ELECTRIC CURRENT—A flow of charged particles, usually electrons (*see below*).

ENERGY—A quantity having the dimensions of a force times a distance which is conserved in all interactions within a closed system. It exists in many forms and can be converted from one form to another. Common units are Calories, joules, BTUs and kilowatt-hours.

ENVIRONMENTAL IMPACT STATEMENT—Analytical statements that attempt to balance costs and benefits of projects from an environmental as well as economic point of view.

FAHRENHEIT—A temperature scale in which the temperature of melting ice is set as 32° and the temperature of boiling water as 212°. One Fahrenheit degree is equal to five-ninths of a Centigrade degree.

FOSSIL FUELS—Any naturally occurring fuel such as coal, crude oil, or natural gas, formed from the fossil remains or organic materials.

FUEL—Any substance that can be burned to produce heat. Sometimes includes materials that can be fissioned in a chain reaction to produce heat.

GASOLINE—A refined petroleum distillate composed primarily of light hydrocarbons. Since light hydrocarbons are a relatively small percentage of crude petroleum, most gasoline is produced by refining ("cracking") crude oil. Gasoline has a boiling range at atmospheric pressure from 80°F to 400°F.

GENERATOR—A device which produces electric energy from mechanical energy.

GROSS NATIONAL PRODUCT (GNP)—A measure of economic activity. GNP is the total market value of all goods and services produced in a country. Depreciation and other allowances for capital consumption are not deducted.

HEAT—A form of kinetic energy that flows from one body to another because of a temperature difference between them. The effects of heat result from the motion of molecules. Heat is usually measured in Calories or British Thermal Units (BTUs).

HORSEPOWER (HP)—A standard unit of power equal to 746 watts.

IMPORT QUOTA—Government-set limits on the importation of foreign products.

INTERMEDIATE ENERGY FORMS—Energy in transit from its natural form to the form in which it is useful.

For example, energy of coal or falling water (the primary energy form) is converted to electricity (the intermediate form) which in turn is converted to heat energy (the final form) in a radiator.

JOULE—A metric unit of work or energy; the energy produced by a force of one newton operating through a distance of one meter.

KEROSENE OR **KEROSINE**—A mixture of hydrocarbons obtained by the fractional distillation of petroleum and used as a fuel for jet engines and gas turbines. It consists of slightly heavier hydrocarbons than are found in gasoline and naphtha.

KILOWATT (KW)—A unit of power, usually used for electric power, equal to 1,000 watts, or to energy consumption at a rate of 1,000 joules per second.

KILOWATT-HOUR (KW-HR)—A unit of work or energy equal to that expended by one kilowatt in one hour. It is equivalent to about 853 Calories of heat energy.

LIFE CYCLE COSTS—The cost of an item year by year, including initial purchase price as well as cost of operation, maintenance, etc. over the life of the item.

LIQUIFIED NATURAL GAS (LNG)—Natural gas that has been cooled to approximately -160°C, a temperature at which it is a liquid. Since liquification greatly reduces the volume of the gas, the costs of storage and shipment are reduced.

NATURAL GAS—A naturally occurring mixture of hydrocarbons found in porous geologic formations under the earth's surface, often in association with petroleum. It is pure methane, CH_4, but also contains small amounts of various more complex hydrocarbons.

NATURAL GAS LIQUID—Components of natural gas which are liquid at room temperature but become gases at slightly higher temperatures. Propane and butane are examples.

NUCLEAR ENERGY—The energy released during reactions of atomic nuclei.

NUCLEAR REACTOR—A device in which a fission chain reaction can be initiated, maintained, and controlled. Its essential component is a core with fissionable fuel. It usually has a moderator, shielding, coolant, and control mechanisms.

"OFF-PEAK" POWER—Power generated during a period of low demand.

OIL SHALE—A sedimentary rock containing a solid organic material called kerogen. When oil shale is heated at high temperatures, the oil is driven out and can be recovered.

OPEN—The Organization of Petroleum Exporting Countries. An organization of countries in the Middle East, North Africa, and South America which aims at developing common oil-marketing policies.

PEAK LOAD—The maximum amount of power delivered during a stated period of time.

PETROCHEMICALS—Chemicals derived from petroleum.

PETROLEUM (*or OIL*)—An oily, flammable liquid that may vary from almost colorless to black and occurs in many places in the upper strata of the earth. It is a complex mixture of hydrocarbons and is the raw material for many products.

PAYBACK PERIOD—The time required for anticipated energy savings to recover the cost of the investment; also termed *recovery rate*.

POWER—The rate at which work is done or energy expended. It is measured in units of energy per unit of time such as calories per second, and in units such as watts and horsepower.

PRIMARY ENERGY—Energy in its naturally-occurring form—coal, oil, uranium, etc.—before conversion to end-use form.

PRODUCTIVITY—The value added to goods divided by the man-hours input.

RADIOACTIVITY—The spontaneous transformation of an atomic nucleus during which it changes from one nuclear species to another with the emission of particles and energy.

RECOVERABLE RESOURCE—That portion of a resource expected to be recovered by present-day techniques and under present economic conditions. Includes geologically expected but unconfirmed resources as well as identified reserves.

RESERVE—That portion of a resource that has been actually discovered and this is presently technically and economically extractable.

RESIDUAL FUEL OIL—The heavy residue of petroleum that remains after lower boiling fractions are distilled. It is used primarily for generating electricity in industry and large commercial buildings.

RESOURCE—The total estimated amount of a mineral fuel, or energy source, whether or not discovered or currently technologically or economically extractable.

R-VALUE—The resistance to heat flow. The higher the "R" value, the greater the insulating efficiency of the material.

RETROFIT—Alteration or modification of an existing structure, or mechanical system or components therein in order to conserve energy.

SET BACK—The lowering of the thermostat setting. The technique is used to reduce the amount of energy required to heat a space.

SOLAR CELL—A device which converts radiant energy directly into electric energy by the photovoltaic process. Each cell produces a small potential difference, typically about 0.5 volts; an array of cells can provide a useful electric power capacity.

SOLAR COLLECTOR—A device for collecting solar energy and converting it into heat.

SOLAR ENERGY—The electromagnetic radiation transmitted by the sun. The earth receives about 4,200 trillion kilowatt-hours per day.

SOLVENT REFINED COAL (SRC)—A tar-like fuel produced from coal by dissolving it in a solvent. It is higher in energy value and contains less sulfur or ash than coal.

STRIP MINING—A mining technique used when deposits of coal lie relatively near the surface (less than 100 feet). The overburden (the soil and rock above the coal) is stripped away, the coal removed, and the overburden from a trench dumped in the previous, and parallel, one. Strip mining is used primarily for coal, but may be used extensively in the mining of oil shale as well.

SYNTHETIC NATURAL GAS (SNG)—A gaseous fuel manufactured from coal. It contains almost pure methane, CH_4, and can be produced by a number of coal gasification schemes. The basic chemical reaction is coal $(C) + 2H_2 - CH_4 =$ heat.

TEMPERATURE—Intuitively, the "hotness" or "coldness" of a substance, a measure of the changes which result from heat energy transfer. The temperature of a substance is proportional to the average kinetic energy of its atoms or molecules.

THERMAL ENERGY—Heat energy.

TON OF AIR CONDITIONING—The thermal refrigeration energy required to melt one ton of ice (2,000 pounds). Also a means of expressing cooling capacity. (1 ton = 12,000 BTU/hour cooling).

"U" VALUE—A coefficient which indicates the energy (BTU's) which passes through a unit area of a surface for every degree (Fahrenheit) of temperature difference from one side to the other under steady state conditions.

VALUE ADDED—The difference between the value of a delivered product and the cost of the raw materials, labor, and energy to produce it.

VOLTAGE—The potential difference measured between two points in an electric circuit. The work per unit charge required to move an electric charge between two points.

WATT (W)—A metric unit of power usually used in electric measurements which gives the rate at which work is done or energy expended. One watt equals one joule of work per second.

WORK—Energy that is transferred from one body to another in such a way that a difference in temperature is not directly involved. The product of an external force times the distance an object moves through its application.

APPENDIX B

ENERGY CONVERSION FACTORS TO BRITISH THERMAL UNITS (BTU)*

Gasoline	125.0	MBTU/Gallon (Gal.)
Kerosene	134.0	MBTU/Gallon (Gal.)
Distillate Oil (#2, #4)	138.7	MBTU/Gallon (Gal.)
Residual Oil (#5, #6)	149.7	MBTU/Gallon (Gal.)
Natural Gas	103.0	MBTU/Hundred Cubic Feet (CCF)
Propane	95.5	MBTU/Gallon (Gal.)
Electricity	11.6	MBTU/Kilowatt Hour (KWH)
Coal	24500.0	MBTU/Ton
Purchased Steam	1.39	MBTU/Pound (lb.)
Horsepower Hour	254.5	MBTU/Horsepower Hour (HPH)

*__Source:__ Preliminary Energy Audit Form for Energy Conservation Grants Under Title 3. The National Energy Conservation Policy Act.

NOTE: **In the table below under column 1...items 4, 6, & 8 the supposed - sign should be DIVISION signs. Designer to pen in dots please!**

USE OF ENERGY CONVERSION FACTORS TO CALCULATE ANNUAL EFFICIENCY INDEX (AEI) AND TO DETERMINE ENERGY SAVINGS

Example:

Assume: Your school system consumed 15,000 gallons of #2 distillate oil in heating your school building in 1978, and in 1979 through energy conservation the consumption of the same heating oils was 10,000 gallons. What is the total energy saved?

Year	**1978**	**1979**
1. #2 Distillate oil consumed	15,000 Gals.	10,000 Gals.
2. Total MBTU consumed (Line 1 × 138.7 MBTU/Gal.)	2080.5 MBTU	1387.0 MBTU
3. Total heated square footage	10,000 Sq. Ft.	10,000 Sq. Ft.
4. Annual efficiency index (AEI) (Line 2 - 3)	.208	.139
5. Annual expenditure for heating oil	$7,500—	$7,500—
6. Energy cost per square foot (Line 5 - Line 3)	$ .75	$ .75
7. Savings in AEI (Line 4 [1978] - Line 4 [1979])		.69 MBTU
8. Per cent of savings in 1979 (Line 7 - Line 4) [1978]		33%

Massachusetts Department of Education
Bureau of School Management Services
31 St. James Avenue
Boston, Massachusetts 02116

Non-Profit
U.S POSTAGE
PAID
Permit No. 55623
Boston, Mass.

MAIL TO: